97-84096-5

Kruttschnitt, Julius

Opening address: Railway fuel, a reducible 13% of...

[S.l.]

[1923]

97-84096-5
MASTER NEGATIVE #

COLUMBIA UNIVERSITY LIBRARIES
PRESERVATION DIVISION

BIBLIOGRAPHIC MICROFORM TARGET

ORIGINAL MATERIAL AS FILMED - EXISTING BIBLIOGRAPHIC RECORD

308
Z
Box 131

Kruttschnitt, Julius, 1854-1925.
... Opening address: Railway fuel, a reducible 13 %of operating expenses, by J. Kruttschnitt... fifteenth annual meeting, Hotel Winton, Cleveland, Ohio, May 21st, 22nd, 23rd and 24th, 1923.
p. 235-253. 23 cm. (International railway fuel association. Pamphlet no. 4)

○

ONLY ED

RESTRICTIONS ON USE: *Reproductions may not be made without permission from Columbia University Libraries.*

TECHNICAL MICROFORM DATA

FILM SIZE: 35mm REDUCTION RATIO: 10:1 IMAGE PLACEMENT: IA [✓ IIA] IB IIB

DATE FILMED: 5-22-97 INITIALS: PB

TRACKING # : 22645

FILMED BY PRESERVATION RESOURCES, BETHLEHEM, PA.

BIBLIOGRAPHIC IRREGULARITIES

MAIN ENTRY: Kruttschnitt, Julius

Opening address: Railway fuel, a reducible 13% of operating expenses

Bibliographic Irregularities in the Original Document:

List all volumes and pages affected; include name of institution if filming borrowed text.

_____ Page(s) missing/not available: _____

_____ Volume(s) missing/not available: _____

_____ Illegible and/or damaged page(s): _____

_____ Page(s) or volume(s) misnumbered: _____

_____ Bound out of sequence: _____

_____ Page(s) or volume(s) filmed from copy borrowed from: _____

X Other: Filmed with advertising, p. 254-280

_____ Inserted material: _____

TRACKING#: MSH22645

PAMPHLET NUMBER 4

INTERNATIONAL RAILWAY FUEL ASSOCIATION

308
Z
Box 12

OPENING ADDRESS

PAGE
Railway Fuel—A Reducible 13% of Operating Expenses 235
By J. Kruttschnitt, Chairman, Executive Committee, Southern Pacific Company

ANNOUNCEMENTS

Advertising 1923 Proceedings 255
Membership Application Blank 275

CONSTITUTION—ARTICLE I

Purpose of the Association

The object of this Association shall be to benefit its members in an educational way and to advance the interests of the employer by the dissemination of information covering the best ideas and practices relative to the **purchase, inspection, weighing, distribution, handling, use** and **accounting** of fuel.

FIFTEENTH ANNUAL MEETING

HOTEL WINTON, CLEVELAND, OHIO

MAY 21st, 22nd, 23rd and 24th, 1923

Sept 2 1923

OPENING ADDRESS

RAILWAY FUEL—A REDUCIBLE 13 PER CENT OF OPERATING EXPENSES

By J. Kruttschnitt
Chairman, Executive Committee, Southern Pacific Company

The United States Geological Survey warns us that we have been depleting those of our coal deposits most easily mined at a steadily increasing rate: that we have mined more coal in the last twelve years than in the preceding 150.

With the upward trend of labor and material costs and difficulties of mining, the cost of coal must rise steadily in the future, and these considerations should stimulate its provident use. In 1921 the railroads used approximately 137,000,000 tons, or 27.3 per cent of the total production of bituminous and anthracite coal in the United States, and its cost of $594,479,000 constituted 13 per cent of total operating expenses. Let us try to visualize the coal represented by these figures, which are bewilderingly large: it would require 68,500 freight trains—40 cars to the train, 50 tons per car—to transport it; they would have to follow each other at intervals of about seven and a half minutes during the entire year to pass a given point. Assembled in one pile it would make a pyramid with base one mile square and 590 feet high.

We have come here to study how to make our railroads more efficient public servants, and to devise how to save as much as possible of the 13 per cent of operating expenses represented by fuel cost. Every one of us should admit frankly his full share of responsibility for our shortcomings. Too often efforts to save fuel go no farther than to criticize the work of the men directly charged with its consumption, and thereafter to rest under the smug impression that we have done our full duty.

While all recognize the great influence of the work of the locomotive fireman who furnishes the steam to run our trains, and of the engineer who applies it to vitalize inert steel and iron, on net earnings, we shall show how substantially every man in railroad service from the chief executive to the humblest private who guards our permanent way, shares in the credit or discredit of operating results.

Fundamentally, a railroad is a manufacturing plant designed to convert the energy locked up in fuel into work for transportation uses on specially designed roadways. The energy conversion is by means of locomotives, and the success of the plant depends on the spread between production costs and selling prices of output, measured in this case in passenger-miles and ton-miles.

Fuel is the largest item of material expense on a railroad, and however efficient our firemen and engineers may be, their efforts would fall far short of the desired end without the perfect co-ordination of every department in the plant, all of which influence cost of output.

The activities of a railroad are centered in the following departments; each must function efficiently alone and also in connection with all others, in order to attain the greatest measure of success:

I. Executive Department

"The location of a railroad is giving it its constitution. It may be sick almost unto death with accidents of construction and management, but with a good constitution it will ultimately recover." The Executive Department must determine the location of the railroad between the termini that the railroad is to connect; it prescribes the amount of money to be spent on construction; fixes the grade and curve systems, because the ideal railroad, between given points, would be absolutely straight and of uniform grade, that is, devoid of undulations in alignment or profile. The locomotive's consumption of fuel will increase in proportion to the grade and curve resistance involved in departures from the ideal line. Whenever a ton weight is lifted one foot, an amount of work equivalent to moving it 333 feet over a straight, level track is spent; and every time a ton weight of train is forced through 100 feet of one degree curve, the work done in deflecting it from a straight to a curved path is equivalent to moving the same ton over 16⅔ feet of straight, level track. The old line of the Central Pacific between Ogden and Lucin, Utah, in a distance of 146.7 miles had 4,260 degrees of curvature, and rose 1,906 feet westbound. The new line, the Lucin Cut-off, in 102.9 miles has 341 degrees of curvature and rises 390.2 feet westbound. The equated straight, level track is 280.2 miles for the old and 128.6 miles for the new line. It takes one pound of coal on the new to move as much as 2.2 pounds of coal moved on the old line.

The Executive Department must determine the justifiable outlay to reduce grades and curvature on existing lines, as obviously the expenditure necessary to obtain a straight line between two points without any undulations in grade might be commercially prohibitive. It is, therefore, of the greatest importance for the commercial success of a railroad to balance the money cost of approaching as nearly as possible ideal conditions against the expected advantages.

Fuel economy can often be effected by expensive physical improvements, such as installing automatic block signals, redesign of terminals, modernizing roundhouses so as to utilize the residual heat from incoming locomotives to raise steam on outgoing ones, and by increasing the number and lengths of sidings to save delays on the line. On the executive rests the responsibility of balancing the interest, maintenance and depreciation costs on large capital expenditures against possible savings, and of providing the necessary capital if the investment is justified.

II. Accounting Department

The Accounting Department keeps track of earnings and expenses, records the history of operations, and acts as general inspectors to expose poor results as a prerequisite to correcting them. No expense should be spared in publishing promptly all data that show results of operation. The record traffic handled with record efficiency in 1917 was the response of the railroads to the monthly data sheets first issued by the Railroads' War Board, which now are issued in even more detail by the Interstate Commerce Commission and the Bureau of Railway Economies. Fuel accounts kept with individual engineers and firemen and locomotives furnish railroads with data from which to decide definitely what type of locomotive is the most economical for their use, and whether the expense of applying and maintaining some of the many fuel-saving devices is warranted. While the experience of the men who make the decisions will usually keep them from going far wrong, yet in matters involving millions in both capital and operating expenses, a railroad officer should not be satisfied unless he has definite figures on which to base decisions.

III. Traffic Department

The Traffic Department sells the output of the railroad plant, and its contracts as to loads in cars and character of service exert a profound influence on fuel consumption.

On a level grade at a speed of 20 miles per hour it requires 460 pounds of tractive effort to haul 50 tons in *two* cars of 21 tons' weight; it requires only 270 pounds to haul 50 tons in *one* car of the same weight, or 41 per cent less. To haul the same car and contents at 40 miles per hour increases traction from 270 to 412 pounds, or 53 per cent; hence the importance of heavy carloads and moderate speed.

IV. Maintenance of Way Department

As the resistance to traction of locomotives and cars varies between wide limits with the condition of the track, the Maintenance of Way Department can greatly reduce expenditure of energy and fuel in moving trains. The train resistance figure commonly used of six pounds per ton of 2,000 pounds at low speed assumes track in good condition. It may very easily be two or three times that amount on poorly maintained track, laid with light rail in bad surface and with low joints, etc. The heavier the rail and the better the ballast, the easier it is to maintain good alignment and surface, the less will be the deflection under loads, and the less will be the work required to force the wheels out of the depression caused by weak and yielding joints.

V. Maintenance of Equipment Department

About one-fifth of all locomotive coal, or 25,000,000 tons, in 1921 was consumed when the locomotive was not doing useful work: in firing up, in waiting for trains, in standing on sidings and passing tracks, in delays at terminals, drawing fire and waiting at ashpits.

While this consumption is not directly productive, it is, of course, not all to be regarded as waste. Locomotives must be fired up and their fires must be cleaned, but substantial economy results from using steam blown off incoming to heat up outgoing locomotives. A certain amount of time must also inevitably be spent in yards, terminals and sidings. All these are essential activities incident to operation, but since so large an amount of coal is involved it is clearly important that these periods should be reduced to a minimum.

This is part of the fuel conservation problem that no one department solely controls; the chief responsibility lies with roundhouse forces, transportation officers and despatchers, who, by the exercise of forethought and close attention to details of grooming and assigning locomotives, can achieve substantial results.

Of every 100 pounds of coal burned while locomotives are running—

1. 70 pounds are applied in making steam;
2. 14 pounds go out of the stack as waste heat in gases;
3. 8 pounds go out of the stack as cinders;
4. 4 pounds go out of the stack as unburned gases;
5. 4 pounds go into the ashpan and ashpit.

These figures are based on *good* performance, which, of course, is much better than the *average* of all the locomotives in the country.

The losses under heads (2), (3), (4) and (5) total 30 per cent and indicate directions in which efforts to save fuel should be made. While it is impossible to eliminate any of these losses entirely, each may be reduced by methods of proven merit. The remaining 70 per cent of the heat in the coal is stored in the steam. Of this store—

52 parts are lost in the steam exhausted from the stack, on its way to perform some useful work in creating draft;
5 parts are lost in radiation;
7 parts are lost in operating air-pumps, injectors, blower and other auxiliaries;
6 parts are used in useful work applied at the locomotive drawbar.

70%—Total.

The percentage of useful work can be increased from 6 per cent to 8.1 per cent, or 35 per cent, by the use of methods and devices that we shall enumerate.

In designing locomotives, the features exercising the greatest influence on fuel efficiency are:

Careful and expert proportioning of engines, boilers, fireboxes, grates, flues, draft appliances, so as to produce by their combination the most perfect device to extract their full heat contents from fuels.

With the increase in the power of locomotives and the use of higher steam pressures, mathematical talent to replace rule of thumb has been called on to compute stresses and to proportion parts. Questions as to adoption of alleged improvements are difficult to decide, as they involve first cost, interest, maintenance and depreciation, their possible effect on engine failures and the idle time of the locomotives while they are undergoing repairs. Sometimes economy of operation is sacrificed to facilitate adjustment and repairs, as when outside valve gears replaced the old Stephenson link motion.

The practice of buying locomotives regardless of their adaptability to special service, as was done during Federal control, simply because they can be built in quantity at some reduction in cost, is recognized by competent judges as the poorest kind of economy.

While it is customary to speak of the waste of fuel in the average locomotive, which converts but 6 per cent of the heat in fuel into useful work, we must not forget the extremely unfavorable conditions under which it is required to work. On account of space limitations it cannot use condensing engines, and thus is deprived of the advantage of 12 to 13 pounds additional effective cylinder pressure. It is driven through all kinds of weather at high speed, so that radiation losses are very great. To meet the demands made on its boiler for steam, explosive draft must be used, which expels much unburned fuel from the firebox; the resultant effect of all of which is evidenced in low thermal efficiency. The Brake thermal efficiency—or percentage of energy in fuel transformed into work —of reciprocating, *condensing, stationary* steam engines is (boilers excluded) 19.0%
Of steam turbines..19.2%
Average of eight large power-plants (boilers included)........................13.3%
While the thermal efficiency of non-condensing steam locomotives at *maximum* capacity, equipped with proven fuel-economizing devices, is from........................7.3% to 8.1%

The fuel-saving devices in most general use are:

BRICK ARCHES

Brick arches built into the firebox mix the entering air thoroughly with the combustible gases rising from the fire, thereby insuring more perfect combustion and preventing the unconsumed fuel in the shape of flames from taking a short-cut into the flues, where they would, by cooling, waste much of the heat value of the fuel. Competent authorities assign them a fuel-saving value on some types of locomotives of about 12 per cent.

SUPERHEATING

The advantages resulting from the use of superheated steam *are due mainly* to two properties:

(a) *Prevention of Cylinder Condensation.* Saturated, non-superheated steam entering the cylinder comes into contact with, and gives up heat to, the metal of the cylinder, steam passages and piston, which have been cooled during the preceding period of expansion and exhaust. Twenty-five per cent (25%) or more of the entering steam may be condensed in this manner before cut off, and thus lose its capacity for useful work.

Since superheated steam has a temperature higher than that corresponding to the point of condensation, it can give up heat to the cooled cylinder walls without condensing any of the steam, thus *entirely avoiding cylinder condensation.*

(b) *Larger Volume Per Pound.*

	Gage Pressure ℔s. per sq. inch	Temperature	Total Heat B. t. u.	Volume Cu. ft. per ℔
Saturated steam	200	387.9°F.	1199.2	2.141
200°F. superheated steam	200	587.9°F.	1309.7	2.84
Percent increase			9.2%	32.7%

Since the cylinder takes the same volume of steam per stroke for the same cut-off, it is obvious that substantially less pounds of steam will be used for the same work done.

Superheating may save 20 per cent of fuel.

FEED-WATER HEATERS

After raising a pound of water to its boiling point, 212° Fahr., 970 thermal units (the British thermal unit B. t. u. being the amount of heat necessary to raise the temperature of one pound of water from 63° to 64° Fahr.) are required merely to change its state from a liquid at 212° to a gas at 212°; conversely, when a pound of steam is exhausted from the cylinders of a locomotive it gives up over 970 thermal units in condensing from a gas into a liquid. A part of the heat-energy in the exhaust steam is utilized to create the draft in the firebox through the grates, but most of it ordinarily is wasted. Feed-water heaters utilize part of this waste heat to raise the temperature of the feed water, thereby relieving the fuel in the firebox from heating the cold feed water from an average of 60° Fahr. up to 220° Fahr. and saving about 10 to 14 per cent of fuel.

The combined average effect of these three devices in saving fuel on passenger and freight locomotives of *various types* at *various speeds* in

actual service is given below, but we must not forget that these figures *vary widely for different locomotives, speeds* and *classes of service,* thus:

	Average, various types and speeds
Arch	9%
Superheater	20%
Feed-water heater	10%
Combined	34.5%

These three devices are of proven value and are coming into extensive use; however, there are others on the market whose claims have not yet been thoroughly substantiated, which may develop into valuable adjuncts to the locomotive.

The savings claimed for the various fuel-saving devices are *gross* figures. The cost of applying them is quite large, and in some cases not justified by the age or obsolescence of the locomotive; in others, is beyond the financial ability of railroads to apply them; hence we must be careful to balance cost of interest, maintenance and depreciation against the value of the fuel saved. The *net* saving so determined—not the *gross*—will show whether the money to provide the appliance can be providently expended or not. Experience shows that thus tested the gross saving of superheaters is reduced from 20 per cent to about 17.4 per cent; of feed-water heaters from 10 per cent to about 6 per cent.

BOOSTERS

Under normal conditions a locomotive can haul as much, or even more, load than it can start. The booster consists of a pair of independent engines coupled to the trailer wheels of locomotives, thus utilizing weight not otherwise used for traction, in starting and quickly accelerating trains and in reducing violent shocks in starting, which are so hard on draft gear and the temper of passengers. As it cuts out automatically at a speed of 10 miles per hour, it uses steam at low speeds when the boiler can over-supply the main cylinders. It is therefore an indirect but valuable fuel saver through increased locomotive capacity. It can add about 10 per cent to the drawbar pull of heavy freight and as much as 25 to 35 per cent to the drawbar pull of lighter passenger locomotives.

However excellent may be the design of the locomotive, close and unremitting attention to the numberless details of operation is necessary to obtain the maximum work with minimum consumption of fuel. We can touch on the principal ones only in the limited time at our disposal:

FEED-WATER PURIFIERS

1. After selecting the softest natural feed waters, such others as we may have to use should be chemically treated to reduce objectionable impurities to a minimum. A conservative estimate of the effect of scale

one-sixteenth inch thick on flues is to increase fuel consumption 10 per cent. The Hungarian State Railroads use on 3,000 locomotives a mechanical feed-water purifier mounted on top of the boiler. The water on entering the purifier is subjected to full boiler pressure and temperature, and deposits its scale in and on this *adjunct to the boiler* instead of *in the boiler* and *on the flues*. With reduction of scale there is a direct saving in fuel consumption, while a reduction in frequency of boiler washings saves considerable time and fuel. Without the purifier, locomotives were washed on an average every five days; with the purifier, every 54 days or 5,000 miles.

LUBRICATION

2. All journal bearings must be carefully lubricated to reduce friction; so must the center—and side-bearings of cars, the friction of which prevents the adjustment of trucks on entering and leaving curves, and thereby in the aggregate causes a heavy increase of the resistance to traction that the locomotive must overcome.

3. Wear on all wheels of locomotives, tenders and cars must be watched. If the treads are worn hollow or flanges worn vertical, the areas in contact with the rails when cars are oscillating or rounding curves will be increased and friction correspondingly increased. A heavy freight locomotive, tender, caboose and 60 freight cars are carried on over 500 wheels; a slight increase in the friction on a few of them only would, in the aggregate, create a heavy drag on the locomotive.

FLANGE LUBRICATION

4. Flange lubrication reduces friction between rail and flanges, and therefore has a substantial effect in reducing fuel consumption. On two roads where flange lubrication was used, locomotive tires showed average miles between turnings of 33,000 and 44,000 miles, respectively, compared with 16,000 and 23,000 without. Wear on rails in curves show reduced wear of as high as 87 per cent. On one road of excessive curvature and grade the life of locomotive tires was increased 375 per cent with flange lubrication.

FUEL SPECIFICATIONS

5. To insure full heat value the specifications for fuels purchased should cover their value in B. t. u's.

MAXIMUM LOADS IN VEHICLES

6. Freight cars should be fully loaded as far as may be. The resistance of a train of *empty* freight cars may run up to eight pounds per ton; that of cars with average loads to six pounds per ton, while that of heavily loaded cars, of total weight, 60 to 70 tons, may be as low as four pounds per ton. The load, in other words, should be carried in as few cars as possible.

REDUCTION OF DEAD WEIGHT

As the expenditure of fuel in hauling a ton is the same whether or not it is paying freight, it is evident that the smaller the percentage of non-paying or dead weight to total weight moved, the smaller will be the fuel consumption in hauling the paying freight.

The United States Railroad Administration 50-ton, single-sheathed box car weighs 47,200;

American Railway Association 50-ton box car design, 42,400;

Excess weight of U. S. R. A. car—4,800 pounds, or 11.3 per cent.

Based on 1921 data, the saving in fuel by eliminating this excess weight, is $9.12 per car per year.

As far as practicable all weight in a locomotive above what is needed for adhesion to develop traction should be eliminated.

Boiler design to suit class of service, and character of fuel, requires considerable flexibility in this principle.

7. The men who run the locomotives should understand the principle of combustion and the economical use of steam. If too little air is admitted to the firebox, much of the fuel in the shape of dense, black smoke will leave the smokestack unburned and wasted; if too much is admitted, all in excess of what is necessary for perfect combustion will be uselessly heated and pass out of the stack carrying valuable heat with it—again a waste. The fireman, master of his business, will take his locomotive over a division, never allowing black smoke to leave the stack. So the experienced engineer will run uniformly, using just enough steam to maintain desired speed and will waste none in bursts of speed, which must be reduced by brake application, which means waste of power and consequently fuel. The work units expended in stopping a heavy freight train of 66 cars weighing, with locomotive and tender, 6,203,700 pounds, from a speed of 40 miles per hour, is 332,000,000 foot-pounds, or 427,000 B. t. u.'s. In storing this energy in this train a locomotive of the best type operating at 8 per cent efficiency would burn 380 pounds of coal.

8. Close supervision to insure (a) schedules that can be made with reasonable certainty, (b) make-up of trains to minimize way and terminal switching, and (c) careful tonnage ratings of locomotives to avoid over- or under-loading, effects substantial fuel economies.

STIMULATION OF INTEREST AND CO-OPERATION IN SAVING FUEL

Assuming that locomotives are properly maintained, in order to obtain the best results from burning fuel we must inspire the interest and secure the co-operation of the men on the footboards of our 65,000 traveling power-plants. How these ends are attained will appear from a brief of the practice on a large railroad system covering many states and operated under the most varied topographical and climatic conditions.

1. Thorough monthly inspections are made of all parts of the engines, boiler and appliances, draft arrangements, etc.; in addition, inspectors provided at each terminal inspect engines on arrival and again before departure to see that no defects remain uncorrected before the engine begins its trip.

2. Statistics systematically collected and classified supply a complete history of operation. To be of most use they are issued immediately after the occurrences they record.

(a) A fuel bureau receives daily report of train and locomotive movements within two days after movement. Ton-miles, fuel consumed per 1,000 ton-miles, tons per train for *each individual locomotive* and *each individual engineer and fireman are then computed,* and the results put into superintendent's hands three to six days after movement, so shortcomings can quickly be detected and corrected.

(b) *Monthly* statements of *individual performance of engineers, firemen,* and *locomotives* are prominently displayed on bulletin boards.

(c) A sheet recapitulating results by divisions is also issued *monthly.*

3. On each division a fuel committee composed of 4 engineers, 4 firemen, 1 conductor, 1 brakeman, serves for six months and holds meetings bi-monthly, the superintendent acting as chairman. The meetings are well advertised and are attended by the superintendent's staff and employes from all related departments, who offer suggestions freely. Experts on operating methods and appliances deliver addresses. Motion pictures illustrating actual road conditions are exhibited. Minutes of meetings are widely distributed and published in employees' magazine.

4. To create emulation between divisions, a red silk banner is awarded quarterly to divisions showing greatest improvement in the previous year.

5. Gold-plated cap badges are awarded quarterly on each division to the engineer and fireman showing best fuel record in through and local freight and passenger service.

6. Each superintendent publishes the names of five engineers and five firemen having the best fuel records for the month in through and local freight, passenger and yard service on a roll of honor, which is posted in roundhouses and printed in employees' magazine. A letter of commendation is sent to each man whose name appears on the roll.

7. The company sends yearly, at its expense, 38 men consisting of an engineer and a fireman from each division with the best fuel records, as its representatives to the annual convention of the International Railway Fuel Association.

As a result of the policy described and of many fuel-saving devices, the company referred to moved 26 per cent more gross ton-miles per pound of fuel in 1922 than in 1913.

VI. TRANSPORTATION DEPARTMENT

We have shown that about 20 per cent of all locomotive fuel is consumed when the locomotive is not doing useful work. The fuel losses involved in firing up outgoing and in blowing off, watering, sanding, wiping and issuing supplies to incoming locomotives occur while the locomotive is in the hands of the Mechanical Department, but these losses are directly affected by the despatch and movement of locomotives that are entirely in the hands of the Transportation Department. Other sources of fuel loss in this department are waiting for trains, standing in sidings and passing tracks, delays at terminals.

(a) *Avoidable* losses from fuel used in firing up, because some fuel must be used for this purpose; losses from unconsumed fuel drawn from fireboxes, from blowing off and cooling down at end of runs; losses incurred while waiting for water, sand and other supplies on roundhouse tracks can be very greatly lessened by reducing the frequency of these occasions as much as possible, and this can be done by lengthening the runs of both passenger and freight locomotives. It is not uncommon now to run freight locomotives over two or three freight divisions, and passenger locomotives over four freight divisions, before cooling them. The following are some examples of modern practice:

PASSENGER

Road	*Run*	*Mileage*
M. K. & T. Ry.	Parsons, Kan., to San Antonio, Texas	651
Union Pacific	Council Bluffs, Iowa, to Denver, Colo.	562.6
Southern Pacific	Ogden, Utah, to Sparks, Nev.	536
Southern Pacific	San Francisco, Calif., to Los Angeles, Calif.	475

FREIGHT

Road	*Run*	*Mileage*
Southern Pacific	El Paso, Texas, to Del Rio, Texas	451
Southern Pacific	Houston, Texas, to Algiers, La.	362
Southern Pacific	San Antonio, Texas, to Fort Worth, Texas	352
Santa Fe	Los Angeles, Calif., to Needles, Calif.	310

(b) We have shown how great loss of energy occurs when a heavy train is stopped. Close attention on the part of despatchers will reduce the number of needless stops, and careful planning will avoid fuel waste from locomotives standing in sidings because of poor meeting points, and from idle time at terminals waiting for trains.

(c) The economy of moving tonnage in as few cars and trains as possible and reduction of empty mileage is obvious.

TREND OF CURRENT AND FUTURE ECONOMIC DEVELOPMENT

We come now to a study of the trend of current and future economic development:

Much idle time and fuel can be saved by carefully designed engine terminal facilities, such as hot-water boiler-washing plants, well located supply tracks, etc., and above all ample shops and modern tools to make repairs quickly.

On a division operated with consolidation locomotives where water is exceptionally good, 16,000 pounds of fuel are saved per locomotive per annum by the installation of a hot-water boiler-washing plant.

Such improved facilities, while requiring large capital outlay, will increase the productive time of locomotives.

The burning of fuel in large terminals and shops should be centralized as far as practicable in order to eliminate starting and stopping losses. Through free use of individual electric motors on large tools and groups of small tools the waste of running long lines of shafting, operating tools needlessly when but one or two on the line are used, can be eliminated and substantial economies can be effected in the 16,000,000 tons of fuel consumed on railroads in shops, stations, etc., etc. Twenty per cent of the power in a large railroad shop was saved by eliminating steam-pipe losses and 13% more by abandoning long lines of shafting and many belts through the substitution of electric for steam power. The changes represented a saving of $120,000 per year.

In locations where electrical energy can be purchased at lower cost than it can be produced by the railroad, opportunities for substantial fuel savings are presented.

The effect of all of the factors influencing increased work obtained out of fuel is shown for Class I railroads in table A, giving the pounds of fuel consumed to move 1,000 gross ton-miles, that is, combined weight of locomotive, cars and lading, for 1920, 1921 and 1922, the only years for which complete data are available; and in table B for a system of over 11,000 miles, for which data are available for 10 years:

A	
1920	172
1921	162
1922	163
Decrease	5.2%

1922 results were adversely affected by tonnage losses due to coal strike.

B	
1913	199
1915	173
1917	164
1919	150
1921	151
1922	148
Decrease	26%

It must be remembered, however, as to these figures that improvements in the design of the locomotives themselves and the better conservation of heat given out by the fuel were not accomplished in a short time, but follow the gradual use of better designs and fuel-saving devices. The railroads in the past ten years have applied fuel-saving devices of proven worth quite freely. There are some 64,528 locomotives in the United States, of which approximately 44,700 are now equipped with brick arches, 33,300 with superheaters and about 300 only with feed-water heaters. The number of feed-water heaters is extremely small; they have but recently been introduced into the United States, but it is encouraging to note that 360 are included in locomotives now under construction.

It is interesting and encouraging to observe from the table given above that, barring occasional reverses, the improvement in the work obtained from a pound of fuel is constant, but it is neither interesting nor encouraging to reflect that we are indebted to European engineers for most of the improvements now in use on our locomotives. This is the case with the improved outside valve gear, superheaters and feed-water heaters, some details of which, however, have been designed by American engineers, but nevertheless it is mortifying to admit that the principles underlying these devices were not first used in our country. The reason of course is that heretofore fuel has been so cheap and easily obtained with us that there was little inducement to pay much attention to its conservation; conditions have radically changed in the last few years, however.

The two principles affecting most profoundly the efficiency of stationary steam engines are compounding and condensing. Compounding alone increases the efficiency of an engine from 12% to 15%, and condensing alone may increase it as much as 30%, that is, condensing alone would increase the efficiency of fuel consumption of locomotives nearly as much as brick arch, superheater and feed-water heater combined, which we have already seen amounts to 34½%. Compounding, which has been used in the United States, at one time very much more than now, will certainly come into use again; so that the combined effect of all the devices we have described, with compounding and condensing superadded, would be:

Brick arch would reduce fuel consumption to of the normal consumption at the present time.	91.0%
The superheater added would reduce it to	72.8%
The feed-water heater added, to	65.5%
Using condensing engine, to	49.1%
Compounding, to	42.7%

Our European railroad brothers are fully alive to the advantages of using a condensing engine on the locomotive, as evidenced by descriptions that have appeared in the technical press in the past year or two.

TURBINE LOCOMOTIVES

Swiss Federal Railways, says the Railway Review of April 16, 1921, are testing a 10-wheel type locomotive, with superheater, driven by a *condensing steam turbine,* located on locomotive frames in front of smoke box. Power is transmitted through reducing gears to a horizontal crankshaft, which in turn transmits it to three pairs of drivers. The turbine makes 8,000 revolutions a minute. Exhaust from turbine is condensed in condenser located under boiler, with water supplied from tender. This water used in condensation is cooled down by dripping from the specially designed tender roof, which extends as a hood over the tender. The draft is furnished by a special fan located in front of the firebox, no steam being wasted to produce a draft in the firebox. It is claimed that tests so far show reduction of fuel consumption of 25% compared with *compound* locomotives of usual construction, and very smooth running at high speeds on account of the reduction of heavy reciprocating parts.

Swedish State Railway has built a turbine locomotive described in the *Railway Review,* August 12, 1922. It consists of two units. The front unit, or what is usually the locomotive, carries the fuel in saddle tanks on the rear end of the boiler; it also carries the condensing plant, the superheater and an independent turbine-driven draft fan and an air pre-heater. The tender on which the machinery rests is supported on a truck with six driving wheels 73 inches in diameter and on a trailer with two 33-inch wheels. The motive power is furnished by a condensing steam turbine of 1,800 horse-power carried on the front end of the tender, which by means of reduction gear drives the three pairs of coupled wheels. The locomotive develops a maximum tractive effort of 27,000 pounds and is designed to operate in fast passenger service up to 60 m. p. h. In a local run of 82 miles with a 600-ton passenger train the coal consumption showed a reduction of 50% below that of a Pacific type locomotive, which it replaced, averaging 67 pounds per thousand ton-miles; with a through train—it fell to 37 pounds per thousand ton-miles.

The most original and interesting feature in this locomotive is the air pre-heater, designed with the superheater to utilize the heat in the waste gases of combination, which leave the ends of the boiler tubes at a temperature of about 600° F. The draft in the firebox, supplied by a fan, is free of the sharp blasts of the ordinary locomotive, and avoids shaking up the fire and blowing unconsumed fuel out of the stack.

High pressure steam from the superheater passes directly to the main turbine, to the independent draft turbine and to boiler feed-pump. This feed-pump forces the condensate into the boiler through three feed-

water heaters in series, in which the feed water is raised to a high temperature with the exhaust steam from the auxiliaries and main turbine.

It is claimed that this locomotive, known as a Ljungstrom Locomotive, shows a fuel consumption of about 50% only of that of a Pacific type locomotive, which it replaced on its present run.

The London and Northwestern Railroad has built an experimental locomotive driven by a condensing turbine which operates a generator, and the power is applied to the driving wheels through four electric motors of 275 horsepower each. The condensing apparatus is carried on the rear one of a double unit.

ELECTRIC LOCOMOTIVES

Where electric current can be generated from water power, trains can be moved very cheaply, but where the current is generated in a steam plant the advantages are not so patent.

The United States Geological Survey Professional Paper No. 123 gives the best fuel rate of eight large steam-electric plants, out of a total of 400 plants studied in 1919, as 2.14 lbs. of coal, or 28,000 B. t. u.'s, to produce one kilowatt hour; hence as one kilowatt hour equals 3,413 B. t. u.'s, the loss in converting the energy in coal into electric energy was 24,587 B. t. u.'s, or 87.8%; in other words, out of 1,000 h. p. potential energy in coal, 878 h. p. is lost in converting it into electric energy by the most modern and efficient steam boilers and engines driving the most efficient electric generators then known. This leaves 122 h. p. available. In transmitting this power to motors of an electric locomotive the average loss is 19%, or 23.18 h. p., leaving 98.82 h. p. out of the original 1,000 available for work; but the internal losses of the electric locomotive will consume 15% of this amount, reducing to 84 h. p. the energy to move trains. The efficiency of the fuel from coal to driving-wheel contact with rail is but 8.4%. The corresponding efficiency of a modern steam locomotive with arches, superheater and feed-water heater is 8.1% under favorable conditions. While under average conditions at the present time the advantage may be more than the 3.7% indicated in favor of the electric locomotive, the spread is hardly attractive enough to tempt capital to assume the expense of interest, depreciation, tax and maintenance expenditures that would have to be incurred in changing from steam to electricity generated in a steam plant. The soundness of this conclusion was demonstrated by studies made of the Sierra Nevada and other heavy grades on the Southern Pacific, where trains are lifted 6,854 feet in 86 miles. Assuming the current generated in a steam station, the interest, taxes, depreciation on additional *net* plant required were demonstrated to be more than three times as great as the estimated savings in operating costs to be obtained from electric operations.

Other considerations, such as smoke prevention, increasing capacity on heavy grades, may influence the problem, but we cannot recall any instance of a change being made, where a steam generated current was used, solely for saving fuel. The steam locomotive is by no means as obsolescent as the propagandists for electric traction would have us believe. In an address "The Last Stand of the Reciprocating Steam Engine," published in the March, 1920, edition of the Journal of the American Institute of Electrical Engineers, a fuel consumption of 100 pounds per 1,000 gross ton-miles by electric locomotives is given as applicable "to conditions universally obtaining on regular profiles." Data published by the Bureau of Railway Economics in September, 1921, show that the fuel consumption on 24,000 selected miles of steam railroad averaged but slightly over 100 pounds per 1,000 ten-miles. Embraced in this mileage was the New York Central, Illinois Central, Chesapeake & Ohio, and St. Louis Southwestern. On 3,142 miles, or 60% of Southern Pacific main-line mileage, the fuel consumption in the same month was approximately 100 pounds, while on the Salt Lake Division, 543 miles, the fuel record in October, 1921, averaged 91 pounds per 1,000 gross ton-miles, for all locomotives.

These are every-day performances, while we must remember that in the case of the Swedish experimental locomotive, and in records of electrically operated trains, the data relate either to experimental runs or to performance under exceptional conditions.

The performance of the modernized steam locomotive in every day service without favorable stage setting is shown in the records of some American roads. On one of them, 26 superheated consolidation locomotives showed in daily service on a run with long grades of 21 feet per mile an average consumption of 63½ pounds of coal per 1,000 gross ton-miles, ranging from 55.8 to 71.7.

Still more creditable to the steam locomotives and the men who drive them are the records of individual runners. Engineer A in two trips with trains of 2,809 tons consumed 48.7 pounds per 1,000 gross ton-miles; Engineer P in eight trips with trains of 2,863 tons consumed 58.2 pounds; Engineer R in fourteen trips with trains of 2,411 tons consumed 58.3 pounds.

INTERNAL COMBUSTION ENGINES

These engines vary widely in thermal efficiency and weights per unit, thus:

	Weight per Brake Horsepower	*Brake Thermal Efficiency*
Automobiles	15 pounds	19.0%
Diesel four-cycle	370 pounds	35.0%
Diesel two-cycle	250 pounds	30.0%

The use of the first type, except perhaps for short runs in exceptional conditions with light vehicles, is prohibitive on railroads, because although the automobile engine is two and one-third times as efficient as the steam locomotive the present cost of its fuel is ten times as great.

The Diesel engine, however, shows the highest thermal efficiency of any engine ever designed. We have seen that the most modern locomotive transforms but about 8% of the heat energy of fuel into work; the Diesel transforms 35%, or over four times as much. Its fuel (crude oil, commonly called Diesel Oil) is not converted into gas as in gasoline engines, but is burned in the cylinder in the form of spray, and the expansive force of the products of combustion provides the motive power. Like the gas engine, however, it cannot start itself; this is usually done by means of compressed air carried in storage tanks. The fuel injected into the cylinder in the form of fine spray meets air intensely heated by compression to 400 or 500 pounds to the inch, and flashes into perfect combustion; the products of combustion acting on the piston furnishing the motive power. Because of its inability to start itself it must use some form of variable speed transmission to start trains; the best way so far devised consists of electric transmission, but the combined engine and generator plants are so heavy as to bar its use for heavy traction. Because of its high thermal efficiency, the Diesel engine offers opportunity to make great savings, and its future is very hopeful.

The *Swiss Federal Railways* have a Diesel-Electric 200 h. p. rail motor car in use. It seats 69 passengers; weighs light, 146,000 pounds; hauls a trailer weighing 66,000 pounds that apparently seats as many passengers as the motor car, and attains a speed of 37 miles an hour on a fuel consumption of 30 to 43 pounds per 1,000 gross ton-miles.

The designs of an *Italian Diesel Locomotive* show the following:

Weight in operation, approximately	117 tons
Horsepower at 18½ m. p. h.	1,000 h. p.
Tractive effort at 18½ m. p. h.	19,840 pounds

The locomotive is started by highly compressed air stored in tanks and fed to cylinders at each end of the locomotives, which start it until sufficient speed is attained to start the Diesel engines; when the compressed air is cut off. The air tanks are recharged by means of a connection with the main engines.

The locomotive has three sets of cylinders, placed horizontally; two in each set actuating opposed pistons, which by means of walking beams and connecting rods transmit power directly to the forward and rear driving wheels through cranks set at angles of 120°.

The locomotive is reversed by means of link-motion gear, which reverses the action of the starting cylinders, and as the Diesels function equally well in both directions and do not go into action until after the locomotive has started, they operate in whichever direction the locomotive is started.

An experimental set of engines has been constructed but no locomotive, so that unfortunately no results of operation are obtainable.

The estimated fuel saving over a steam locomotive is 66⅔%.

This design shows progress in adapting the Diesel engines to locomotives of serviceable commercial sizes, particularly in solving the problem of weight, as the weight of a steam locomotive and tender to develop about 20,000 pounds tractive effort is 150 tons.

Use of Low-Grade Fuels and Slack Coal, Lignites

Little use is now made of lignites—low-grade fuels of which we have enormous supplies in the United States. Much of it is easily mined at shallow depths, and its extensive use would save a corresponding amount of our higher-grade, more expensive fuels.

PULVERIZED FUEL

A good many experiments of varying success have been made in burning pulverized fuel on locomotives.

Reports of tests made on the *Santa Fe* do not indicate any very conclusive results.

Experiments on *New York Central* with 10-wheel freight locomotives with 60 to 65 freight cars, with pulverized fuel, B. t. u.'s from 14,000 to 14,739 per pound, show consumption on three tests 70 pounds per 1,000 ton-miles on lowest and 86 pounds per 1,000 ton-miles on highest. General results excellent; there was less than one cubic foot of slag and practically no ash in firebox and no soot on the flues at the end of each trip.

Chicago & Northwestern experiments in road passenger service satisfactory as to steam and time-making. B. t. u.'s in fuel per pound 13,964. A test of North Dakota lignite, B. t. u.'s 10,960, proved generally satisfactory.

TRENT AMALGAM PROCESS

Pulverized anthracite and bituminous slack is mixed with about six times its weight of water. The product is fed into agitators, into which thin streams of 30° Baume fuel oil are introduced in four different stages of agitation. The oil amalgamates with the fine particles of coal. The effluent flows into a belted sieve, the amalgam being conveyed to the finished product pile and the liquid passing through.

The process seems to be based on the discovery that the amalgam of oil and coal occurs in particles just too large to pass through a sieve through which the dirty water will pass.

The amalgam is a plastic product, which has been used to some extent in heating office buildings in Washington.

Tests on locomotives on the Richmond, Fredericksburg & Potomac Railroad and in yard service by the Baldwin Locomotive works proved very satisfactory. The amalgam was high in B. t. u.'s and produced no ash.

COLLOIDAL FUEL

"Colloidal fuel is a stable liquid mixture of pulverized coal or coke suspended in mineral oil or blended oil and tar. It is atomized and burned as a liquid fuel, using the ordinary pre-heat of fuel-oil." * * *

It ranges from a free flowing fluid containing 30% of powdered coal, 69% of oil and 1% of fixature to mixtures containing as high as 60% of coal; B. t. u.'s 16,675.

The use of these coal and oil mixtures immediately increases the available fuel oil supply by from 35 to 50%, at the same time producing a fuel that gives an almost equivalent B. t. u. content at a cost of from 15% to 25% less than fuel oil.

From what we have shown it would seem that the hope of the future for conserving fuel lies in:

1. Substituting hydro-electric current for steam, as our best steam locomotives can now fully equal the efficiency of electric locomotives using current generated in steam power stations.

2. Substituting steam turbines or compound condensing or turbine condensing engines for the simple engines now used on our locomotives. From progress already made in Europe, the solution of this problem appears encouraging.

3. The discovery of a cheap, high-gravity fuel that can be used in some such engine as is used on automobiles and airplanes.

4. Reduction of the weights of Diesel engines sufficiently to permit of their use as locomotive engines. Claims have been made that by compounding Diesels can be made to weigh about one-sixth as much as they now do, but as yet these claims have not been substantiated, in the form of a commercially practicable engine.

5. The development of a satisfactory variable speed transmission gear, to couple the Diesel engine to the driving wheels of a locomotive, which will weigh very much less than the electric generator and motor, would go far towards establishing the Diesel engine as a locomotive prime mover.

Emmons Coal Mining Company

Land Title Building
Philadelphia, Pa.

Mine Operators and Exclusive Sales Agents

Our operations located in the best fields of Pennsylvania, West Virginia, Ohio, Indiana and Illinois, produce high-grade Steam and Gas Coals, which are especially suited for LOCOMOTIVE uses.

Your FUEL inquiries are requested.

Sales Agents for IRVONA COAL AND COKE COMPANY, producers of the celebrated IRVONA Miller Vein Smithing Coal.

"Quality and Service at All Times"

ADVERTISING 1923 PROCEEDINGS

The following memorandum explains the plan of handling our advertising for the year 1923.

Each advertiser in the 1922 Book of Proceedings who signifies the intention of advertising in the 1923 Book of Proceedings may have the 1922 advertisement repeated in one of the 1923 pamphlets containing the advance reports and papers, *without additional charge* and may make any desired change in the advertisement before June first for inclusion in the Book of Proceedings.

All advertisers—both 1922 and new ones—by promptly submitting new copy, may have the advertisement appear in both the Book of Proceedings and in one of the pamphlets containing the advance copies of papers and reports, the rates being:

One-half page	$ 25.00	
Full page	50.00	
Inside front and inside back covers	75.00	(Front Taken)
Pages next to inside front and inside back covers	75.00	(Front Taken)
Pages next to reading matter	75.00	(Front Taken)
Outside back cover	300.00	(Taken)

Size of page is 6x9 inches and size of type space 4½x7½ inches.

It is hoped that all advertisers will avail themselves of this double circulation at one price.

In order to stimulate the securing of advertisements we will credit the advertisement to any member (or divide the credit between two or more members) of the Association, or in the event no designation is made, we will credit same to the "Association."

Below is a list of those who have so far signified their intention of advertising in the 1923 Proceedings. Please solicit advertising from those not listed. Your prompt handling of this matter will prevent delay in issuance of the Proceedings.

LIST OF ADVERTISERS 1923 PROCEEDINGS

Adams, Rowe & Norman
Aetna Combustion Company
American Arch Company
C. L. Ayers Coal Company
Bell & Zoller Coal Company
Berwind Fuel Company
Bewley-Darst Coal Company
Big Creek Coals, Inc.
Blackwood Coal & Coke Company
Walter Bledsoe & Co.
Brothers Valley Coal Company
Buffalo-Pitts Company
Carbon Fuel Company
Central Coal & Coke Company
Century Coal Company
Chicago, Wil. & Franklin Coal Co.
Coal Operators Sales Company
Colorado Fuel & Iron Company
The Consolidated Coal Co. of St. Louis
The Consolidation Coal Company
R. M. Davis Coal Company
Dawson Fuel Sales Company
Dearborn Chemical Company
J. K. Dering Coal Company
Elkins Fuel Company
Elvin Mechanical Stoker Company
Emmons Coal Mining Company
Erie Coal Mining Company
Ford Collieries Company
Franklin Railway Supply Company
Galena Signal Oil Company
Gauley Mountain Coal Company
Grider Coal Sales Agency
M. A. Hanna & Co.
Percy Heilner & Son
Hulson Grate Company
Hunt-Spiller Mfg. Corporation
Hutchinson Coal Company
Industrial Works
Indiana & Illinois Coal Corporation
International Correspondence Schools
Island Creek Coal Company
Johns-Manville, Inc.
Leckie Coal Co., Inc.
Locomotive Finished Material Co.
Locomotive Firebox Company
Locomotive Stoker Company
John A. Logan Coal Company
F. R. Long & Company, Inc.
Madeira, Hill & Company
Maher Collieries Company
Manning, Maxwell & Moore, Inc.
Marion County Coal Company
W. A. Marshall & Company
Midland Coal Company
Midvale Coal Company
Monmouth Coal Company
Monro-Warrior Coal & Coke Company
Nason Coal Company
National Boiler Washing Company
Old Ben Coal Corporation
The Oxweld Railroad Service Co.
Peabody Coal Company
Penn York Coal & Coke Company
Pennsylvania Coal & Coke Corporation
The Pittsburgh & Ohio Mining Co.
Providence Coal Mining Company
Pratt Consolidated Coal Company
The Pyle-National Company
The Rocky Mountain Fuel Company
Sitnek Fuel Company
Smokeless Fuel Company
Smoky Hollow Coal Company
Southern Coal Company
Southern Coal Coke & Mining Co.
Southwestern Coal Company
Standard Coal Company
Standard Stoker Company
Star Coal Co. (of Galesburg)
Star Coal Company (of Kansas City)
The Superheater Company
Swastika Fuel Company
The Texas Company
The Tildesley Coal Company
The B. C. Tucker Coal Company
Union Collieries Company
The Valley Camp Coal Company
Wallace Coal Company
Wentz Company
West Kentucky Coal Company
West Virginia Coal Company of St. Louis
Whitley & Foedisch
Whitney & Kemmerer
Worthington Pump & Machinery Corporation
Youghiogheny & Ohio Coal Company

CREDIT FOR SECURING 1923 ADVERTISING

The following have been credited with 1923 advertising in amounts shown:

Name	*Amount*
I. R. F. A.	$ 900
J. G. Crawford	600
W. L. Robinson	425
C. M. Butler	400
J. N. Clark	225
T. Duff Smith	200
C. P. Dampman	200
T. C. Bowden	150
C. H. Dyson	125
H. Woods	100
P. E. Bast	75
Robt. Collett	75
W. J. Bohan	50
O. J. Brown	50
Jos. Keller	50
J. F. Ryan	50
H. T. Bentley	25
J. W. Dodge	25
J. F. Manning	25
Hugh McVeagh	25
L. R. Pyle	25
Total	$3,800

Corrected to May 18, 1923.

List arranged in order of amount of advertising secured.

Please solicit advertisements or write the Secretary-Treasurer, giving list of those whose advertisements you wish solicited.

ADAMS, ROWE & NORMAN

COAL AND COKE

BROWN-MARX BUILDING

BIRMINGHAM, ALABAMA

Locomotive Coal

Washed & Sized Smithing Coal

Gas, Steam and Domestic Coal

Hand Picked 72 Hour Foundry Coke

Annual Tonnage $2\frac{1}{2}$ Million

W. C. Adams J. A. Norman E. J. Rowe

Star Coal Company
of Galesburg
W. R. HAWKINS, General Manager

GOOD COAL

Prompt Service

GENERAL OFFICES
66 North Prairie Street
GALESBURG, ILL.

WHAT does an analysis of LOGAN COAL show?

That is a question asked us very often, so this information must be of interest to many coal buyers.

The state of Minnesota can be classified as a "particular" coal buyer. They carefully analyze all the coal they buy. An analysis made by the state on LOGAN COAL (No. 2 stove) shipped to the state prison at Stillwater, Minn., shows the following analysis:

Moisture	6.9
Sulphur	2.7
Ash	7.8
B. t. u. Commercial	12,240

LOGAN COAL has proven very satisfactory to the State of Minnesota. It cannot help but meet the approval of all well informed coal buyers

Franklin County Coal

John A. Logan Coal Co.

76 WEST MONROE STREET, CHICAGO

Minneapolis—Lumber Exchange Bldg.

Shipments from Logan, Franklin County, Ill., via
C., B. & Q. and Illinois Central Railway

PREMIUM COAL

Highest Quality Bituminous

An Economical Steam Producer

BIG CREEK COALS INC.

Peoples Gas Building

OMAHA **Chicago** **MINNEAPOLIS**

F. R. LONG & CO., Inc.

Broadway and 34th Street
New York City

Suppliers of Railroad Fuel

Service that is an Asset

to any

RAILROAD

F. KOHL, President
E. E. FYKE, Vice-Pres. and Gen. Mgr.
HARRY KOHL, Treasurer

Marion County Coal Co.

PRODUCERS OF

GLENRIDGE COAL

PREPARED DOMESTIC SIZES
6-Inch Lump, 6 x 3-Inch Egg, 3 x 2-Inch Nut

MINES LOCATED ON
Illinois Central and C. B. & Q. R. R.
At Centralia, Ill.
Reaching all points West and Northwest

Service and Quality

EXCEEDED BY NONE

Telephone Harrison 0658

CHAS. B. CONE, Mgr. of Sales,
536 McCormick Bldg., Chicago

Executive Office and Mines,
Centralia, Illinois

ELKINS FUEL COMPANY

HOTTER'N H— QUALITY FIRST ELKINS LONG FLAME

MINERS **SHIPPERS**

MORGANTOWN, W. VA.

Eastern Office: BETHLEHEM, PA.

Madeira, Hill & Company

260 South Broad Street
PHILADELPHIA, PA.

Anthracite COAL Bituminous

Mines located on Pennsylvania, Lehigh Valley, New York Central, Philadelphia & Reading, Baltimore & Ohio, Delaware & Hudson and Erie Railroads

NEW YORK OFFICE: 143 LIBERTY ST.

The Old Reliable

Handling Railway Fuel at Lowest Possible Cost

Industrial Cranes

Are in use on over 420 different railroads in the United States, Canada, Mexico, Japan, China, Australia, India, Russia, France, Southern America and Cuba.

One railroad alone owns 214 INDUSTRIAL CRANES, another 93.

What greater evidence could prove that INDUSTRIAL CRANES give superior service in railroad work?

Our Sales Engineers are in your vicinity

INDUSTRIAL WORKS

BAY CITY MICHIGAN

1873 BUILDERS OF CRANES FOR 50 YEARS 1923

New York Chicago Philadelphia Detroit

The Oxweld Railroad Service Company

REPRESENTING

THE LINDE AIR PRODUCTS CO.
(Linde Oxygen)

UNION CARBIDE SALES CO.
(Union Carbide)

THE PREST-O-LITE CO., Inc.
(Prest-O-Lite Acetylene)

OXWELD ACETYLENE CO.
(Oxweld Apparatus and Supplies)

30 East 42nd Street, New York
Railway Exchange, Chicago

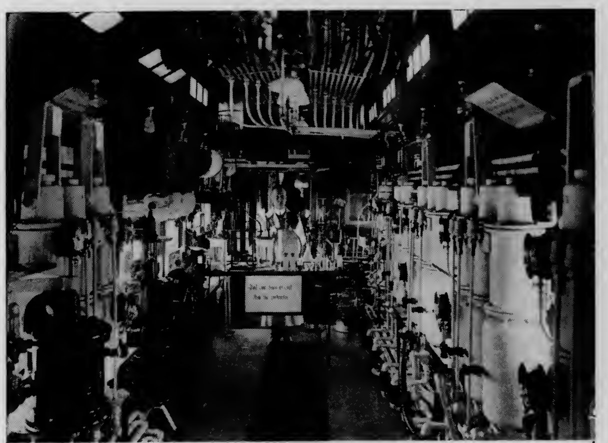
PENN YORK COAL & COKE CO.

Keenan Building, Pittsburgh
General Sales Agents

Erie Coal Mining Company

Erie Mines Nos. 1, 2, 3, 4 & 5, on the Hilliards Branch
Bessemer & Lake Erie Railroad

High Grade, High Volatile Steam Coal
2690°—Fusing Point of Ash
Picking Tables **Shaker Screens**



Interior of one of the six FUEL ECONOMY CARS operated by the I. C. S.

Six cars for demonstrating

FUEL ECONOMY

at your service

Railway Executives:

DO YOU realize that the Railroad Service Division of the International Correspondence Schools operates six instruction cars in connection with their air-brake and fuel economy demonstrations to railroad employees? Arrangements can be made so that the use of these cars is of little or no cost to a railroad company.

For further information, please address

RAILROAD SERVICE DIVISION
International Correspondence Schools
Box 1718, Scranton, Pa.

7000 TONS DAILY

"TRADEWATER" COAL

TRADEWATER
BURNS WELL
BITUMINOUS

Steam and Domestic

QUALITY - - - - SERVICE

Large Railroad Orders

Handled Promptly

West Kentucky Coal Co.

INCORPORATED

Shipping Points: STURGIS & WHEATCROFT, KENTUCKY

General Sales Office PADUCAH, KENTUCKY

Philadelphia
Washington
Cleveland
Hartford
Johnstown
Morgantown

W. A. MARSHALL & CO.

INCORPORATED

25 Beaver Street New York City

We Specialize in

RAILROAD FUEL

Sole Shippers of

LINCOLN Nant-Y-Glo
BETHEL Miller Vein
MAPLE RIDGE C'
MELCROFT Indian Creek
WOLF DEN Stoker Coal
JERE Scott's Run
BERRY Sewickley
HARVE-MACK "B" Vein
ROBERTA Medium Volatile Moshannon

YEARLY CAPACITY 1,800,000 TONS

"A satisfactory contract has two essentials—a shipper of proven integrity and a coal of known quality."

W. A. MARSHALL & CO. OF CANADA, Ltd.

Coal for Canadian Roads

86 NOTRE DAME ST., WEST
MONTREAL, P. Q.

401 TEMPLE BLDG.
TORONTO, ONT.

Longer Engine Runs?

Hulson Grates solve the problem of

CLEANER FIRES

The Hulson Grate is no longer an experiment; its adoption as standard equipment affects all branches of railroading. The change is easily and quickly made. The applications pay for themselves in from thirty to sixty days. Start your investigation now.

Hulson Grate Company

Manufacturers of the Hulson Grate for
Stationary Boilers, Locomotives and Kilns

Keokuk, Iowa

Providence Coal Mining Company

Incorporated

Providence, Kentucky

Miners and Shippers of No. 9
WESTERN KENTUCKY COAL

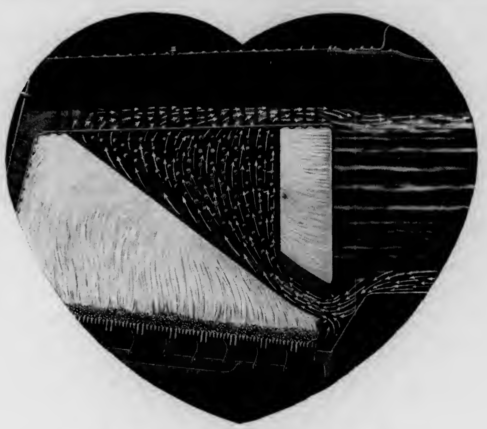
Mines Located on
Illinois Central and Louisville & Nashville Railroads

JOHNS-MANVILLE RAILROAD SUPPLIES

- Asbestos Packings
- Asbestos Protected Metal
- Asbestos Roofings
- Asbestos Shingles
- Ebony & Transite Asbestos Wood
- Expander Rings for Air Brake Cylinders
- High Temperature Cements
- Industrial Flooring
- Locomotive Lagging
- Locomotive Packings, including Air Pump, Throttle, Valve, Stem, Cab Cock, Gaskets, etc.
- Locomotive Spiral Pipe Covering
- No. 82 Moulded Packing Cups and Expander Rings for Power Reverse Gear Cylinders
- Orangeburg Fibre Conduit
- Orangeburg Underfloor Duct System
- Pipe Covering for all classes of service
- Refrigerator Car Insulation
- Steam and Radiator Traps
- Steel Passenger Car Insulation
- Transite Asbestos Smoke Jacks
- Transite Corrugated Asbestos Roofing and Siding

Through—
Asbestos
and its allied products
INSULATION
BRAKE LININGS
ROOFINGS
PACKINGS
CEMENTS
FIRE PREVENTION PRODUCTS

JOHNS-MANVILLE, INC.
New York City
Branches in 56 Large Cities



THERMIC SYPHON
REDUCES FUEL CONSUMPTION

INCREASES boiler capacity by placing a large increase of heating surface in the firebox where water evaporation is the greatest. This solves the problem of "over cylindered" locomotives.

In the interest of economy, efficiency and safety, Syphons should be used in every locomotive.

LOCOMOTIVE FIREBOX COMPANY

Marquette Building, Chicago, Illinois

THE HOLDEN COMPANY, LIMITED
Montreal Toronto Winnipeg Vancouver

Brothers Valley Coal Co.

90 West Street, New York

MINERS and SHIPPERS of

Pen-Mar Smokeless Coal

Unexcelled for Steam and Domestic Purposes

Also

"B. V." Smithing Coal

Daily Capacity 5000 Tons

W. E. McCAULEY, Traffic Manager, Union Trust Bldg., BALTIMORE, MD.

The Gauley Mountain Coal Co.

MINERS OF

HIGH GRADE GAS COAL

Proximate Analysis

Moisture	1.44%
Volatile matter	34.20%
Fixed carbon	60.80%
Ash	3.56%
	100.00%
Sulphur	0.77%
B. T. U.'s dry coal	14,855
Fusing point of ash	2728° F.

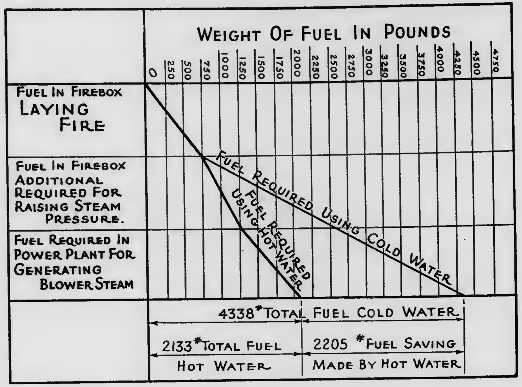
Ultimate Analysis

Carbon	82.63%
Hydrogen	5.80%
Oxygen	5.36%
Nitrogen	1.80%
Sulphur	0.79%
Ash	3.62%
	100.00%

MINES: Ansted and Jodie, Fayette County, West Virginia

SALES OFFICES: 523-524 American National Bank Bldg., Richmond, Va.

THIS IS A GRAPHIC CHART SHOWING THE FUEL COST OF RAISING 100 POUNDS OF STEAM ON A LOCOMOTIVE, BOTH WITH COLD AND HOT WATER



IN ADDITION TO THE FUEL SAVING, NATIONAL WATER BOILER WASHING AND RE-FILLING SYSTEMS SAVE SEVERAL HOURS IN TIME FOR EACH LOCOMOTIVE WASHED. WRITE FOR FULL DETAILS

National Boiler Washing Co.
OF ILLINOIS

Railway Exchange Building, Chicago, Illinois
Works: Barrington, Illinois

"Old Ben"
"Purity"
"Christopher"

Franklin County Coal

The Most Perfectly Prepared
Bituminous Coal Obtainable

Mined and Shipped by

Old Ben Coal Corporation

Chicago, Ill. Minneapolis, Minn.

NASON
COAL COMPANY
Old Colony Building :: Chicago

We Mine and Sell
Reliance AND Empire
COALS

MINES AT	MINES ON
SPRINGFIELD, ILLINOIS	BIG FOUR
AUBURN, ILLINOIS	CHICAGO & ALTON
VIRDEN, ILLINOIS	CHICAGO, BURLINGTON & QUINCY
GIRARD, ILLINOIS	CHICAGO & EASTERN ILLINOIS
NOKOMIS, ILLINOIS	CHICAGO & NORTHWESTERN
	CHICAGO, PEORIA & ST. LOUIS

Capacity: 300 Cars Daily

Pennsylvania Coal & Coke Corporation

Miners and Shippers

PARDEE STEAM COALS WEBSTER

Webster Selected Smithing Coal

New York, 17 Battery Place

Philadelphia, Land Title Bldg.
Hartford, 36 Pearl Street

Boston, 141 Milk Street
Syracuse, Union Bldg.

International Railway Fuel Association
APPLICATION FOR MEMBERSHIP

Date..

Name ....

Title or Position..

Railroad or Firm..

MAIL ADDRESS

Street and Number..

Town ....

State .... | Room Number and Building (if necessary)

EXTRACTS FROM CONSTITUTION

ARTICLE V—FEES AND DUES

The admission fee shall be $2.00 for those residing in the Continental United States, except Alaska, and Canada.

There shall be no admission fee for those residing in Alaska and other than the Continental United States and Canada.

The annual dues shall be $5.00 per year, due and payable on January first. If application for membership is made between January first and before the close of the annual meeting the admission fee and current dues shall accompany the application.

If application for membership is made after the close of the annual meeting the admission fee shall accompany the application, and no dues will be collected for the remainder of the fiscal year.

IF APPLICATION IS FOR NEW MEMBERSHIP

$2.00 or $7.00 (see extract from Constitution next above) should accompany this application, or if you prefer and so advise, we will bill against your company for that amount.

IF APPLICATION IS FOR REINSTATEMENT OF MEMBERSHIP

$5.00 plus previous indebtedness should accompany this application, or if you prefer and so advise, we will bill against your company for that amount or any part thereof.

Memberships are Transferable, but can be held only by an Individual
Send application with your personal check, drawn on any bank in the United States or Canada, payable to the International Railway Fuel Association,
702 E. 51st St., Chicago

DO NOT FILL IN BLANKS BELOW THIS LINE

RECEIVED the following subject to approval of Executive Committee:

Admission Fee - $..................

Current Dues - - $..................

Previous Indebtedness $..................

Total - $..................

SECRETARY'S RECORD

LIST	ENTERED BY			DATE
	A	B	C	
Checked for D. N. P. D.				
No. of Membership Card Issued				
Entered on Alphabetical Member List				
Entered on Classified Member List				
Addressograph Plate Ordered				
Bill Card Made				

Monmouth Coal Company
BRERETON, ILLINOIS
W. J. SPENCER, President

MINES
Fulton County, Illinois

PHONE
Canton, Ill., Main 42

SUGGESTED SUBJECTS FOR 1924 MEETING

Submitted by...
Please sign on this line

SUBJECTS	WRITER OR CHAIRMAN OF COMMITTEE

Please fill in and return promptly to International Railway Fuel Association, 702 East 51st street, Chicago.

J. G. Crawford,
Secretary-Treasurer.

Note: The Secretary keeps a file of suggested subjects for use of the Executive Committee. Every subject received is considered.

International Railway Fuel Association

ORDER BLANK FOR PROCEEDINGS

International Railway Fuel Association,
J. G. Crawford, Secretary-Treasurer,
702 East 51st Street,
Chicago, Ill.

....19........

Send proceedings as indicated below to address and under form of payment shown:—

Meeting Number	Year	PRICE PER COPY		NO. OF COPIES WANTED		Amount
		Leather Binding	Paper Binding	Leather Binding	Paper Binding	
1	1909	Out of Print		▬	▬	$
2	1910	Out of Print		▬	▬	
3	1911	$1.00	Out of Print		▬	
4	1912	1.00	$0.50			
5	1913	1.00	.50			
6	1914	1.00	Out of Print		▬	
7	1915	1.00	.50			
8	1916	1.50	.50			
9	1917	Out of Print	1.00	▬		
10	1918	1.00	None issued		▬	
11	1919	2.00	None issued		▬	
12	1920	2.00	None issued		▬	
		Leather Binding	Imit. Leather Binding			
13	1921	3.75*	3.00			
14	1922	3.75*	3.00			
				Total Amount of Bill		

Name

Title or Position

Railroad or Firm, etc.

Mail Address
Street and Number
Town
State Room Number and Building

PLEASE INDICATE FORM OF PAYMENT

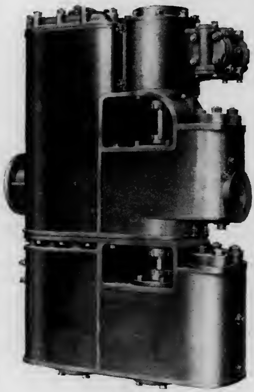
Check, Draft or Money Order with order ________
Bill to be made against me personally________
Bill to be made against above company________

All members should have complete file of proceedings, in so far as it is possible to obtain same.

---

*Only a few of these issued. Members may exchange their imitation leather bound copies for the genuine leather bound copies on payment of seventy-five cents.

Worthington Locomotive Boiler Feed Pump and Feed Water Heater



Saves 10% of Coal

It is a self-contained unit—a feed pump and feed heater of the open type that returns all of the condensate back to the boiler. This feed heating unit raises the steaming capacity of the boiler by at least 10% the year 'round, and saves enough coal to earn its original cost in a comparatively short time.

Other Worthington apparatus adapted to railroad use includes power plant auxiliaries, open feed heaters, air compressors, oil engines and pumping station equipment.

WORTHINGTON PUMP
AND MACHINERY CORP.
Executive Offices:
115 Broadway, New York City
Branch Offices in 24 Large Cities

Pumps—Compressors—Condensers—Oil & Gas Engines—Meters—Mining—Rock Crushing and Cement Machinery

WORTHINGTON

MSH 02645

END OF
TITLE